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Hyperfine interactions in cubic metals using perturbed angular correlation techniques

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SUMMARY

This thesis consists of two parts. In the first an investigation is described of magnetic hyperfine fields of the s-type impurity atoms Zr, Cs, Ba and La in Fe and Ni. These elements have a very low solubility in Fe and Ni, and, therefore, can not be introduced in the host metals by normal methods such as alloying or diffusion. Instead, they were implanted as radio-active ions with the aid of an isotope separator or by the recoil transferred in a nuclear reaction. It is known that in this way almost every impurity atom can be introduced substitutionally in the lattice to a fair degree. To measure the hyperfine fields the perturbed angular correlation technique was used. At least one suitable probe is available for each of the above mentioned elements.

The fields of Zr in Fe and Ni were studied in-beam by the perturbed angular distribution technique, using the KVI-cyclotron. The observed fields follow the systematic trend in this region of the periodic system.

Ba and Ce isotopes were implanted to investigate the fields of Cs, Ba and La. In all cases the fractions of atoms at substitional lattice positions were small, for Ba even less than 15%. Definite hyperfine fields could not be derived in all cases.

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The second object of investigation concerns the electric field gradient (EFG) at nearest neighbours of impurity atoms in dilute fcc alloys of Cu, Ag and Au, using the probes ^{100}Rh and ^{111}Cd. The EFG was found to depend very sensitively on the distance between probe atom and neighbouring impurity atom. It is mainly determined by the screening of the impurity charge by the conduction electrons. We applied Langer and Vosko's first principles theory to calculate this effect. The results deviate substantially from asymptotic approaches that were used earlier. It can be shown that the asymmetry of the EFG tensor is caused by the redistribution of conduction electron charge at the neighbouring host atoms.